Journal for Re Attach Therapy and Developmental Diversities
eISSN: 2589-7799
2023 August; 6 (10s): 726-737

Science Teaching from a Distance: Readiness and Resilience in a Post-Pandemic World

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Received: 20- June -2023
Revised: 02- July -2023
Accepted: 15- August -2023

Abstract

Most people's everyday schedules have been interrupted by the COVID-19 outbreak, kept them homebound, forced the closure of companies and schools, and brought online learning into widespread use. The pandemic is not over yet. Pandemic will continually affect the delivery of knowledge and skills at all levels of education. The education sector must brace to face possibilities. This research explored and investigated the different ways and tools the science teachers in HEIs employed in teaching during Covid 19. This is to prepare them for future uncertainties. The study used systematic review research and used the PRISMA flow 2020 to identify the literatures. The approach of thematic analysis developed by Braun and Clarke was used to analyze and generate themes. The data shows that higher education science teachers during pandemic created innovations in their delivery online. They performed and *acquired flexible teaching strategies, interactive and participatory technology-aided techniques, teaching skills, and technological applications and tools.* This further shows that science teachers in HEIs were equipped with proper training and acquired basic skills in teaching different disciplines such as the strategies and techniques. Teachers' exposure to technology prior to the pandemic helps a lot in their online delivery. It is highly recommended that HEIs will enhance and empower the teachers in science and in other areas for online teaching by conducting training, seminars and workshops. This will make them equipped with strategies and skills in the uncertainties of time and become ready and resilient in a post-pandemic world.

Keywords: Science Teaching, Online Teaching, Teaching Strategies, Technology, Teaching Higher Education, Future Health Outbreak, Covid 19 Pandemic

1. Rationale

At all educational levels, how knowledge and skills are taught is impacted by the COVID-19 epidemic. In the aftermath of the pandemic, it will still have an impact. Some kids and adults could have trouble adjusting to the new techniques, despite the fact that many people will likely compensate for the interruption of the conventional educational programs. There is currently a gap for those whose families lack the time and skills to give the instruction and oversight of schooling required for in-home education. (Hoofman, et al., 2021).

The activities have been hampered by the COVID-19 pandemic. Many people must cope with drastic measures like the shutdown of businesses and schools, social exclusion, work-from-home programs, and social distance (Tanucan & Uytico, 2021). Many schools in the world offer different strategies and modes of teaching. Virtual classes and module distance learning are the most common modes of teaching and learning. The latter requires structural presence, community involvement, intervention presence, and quality to be more effective in its implementation (Tanucan, et al., 2023).

To fit into the situation of health outbreak, the government put strategies into effect such as shutting down school and the onset of digital learning and teaching, visits to households in areas with weak internet signals, and classes at different times to avoid crowding. The government established contests for best school, teacher, staff, and student awards during the new normal in an initiative to reignite pupils' enthusiasm in learning and the passion of teachers in class (Yunus, et al., 2022).

Several months after the onset of the pandemic, the schools slowly started to go back into the teaching and learning journey. A lot of schools continue to deliver quality education and all schools deliver through remote learning. Different modes of delivery were used, such as online delivery, podcast, video conferencing, video viewing and module-based instruction. Along with these delivery modes are the different factors that were conducted and

utilized by the science teachers in order to deliver learning and achieve the competencies set by the standards to catch up the idle period during early months on the onset of pandemic.

However, it's common for viruses to transform and change as they gradually spread between individuals over time. Different variants will be developed (WHO, 2019). At least 70% of the entire population needs to be immunized, 2.4 million older persons who have not received even one dose of vaccination should receive special attention. Then again, Everyone must still continue to wear mask, physical distancing, providing good ventilation, and hand washing. If the practice continues, the next COVID-19 wave will be ready for the world. But,if individuals don't do that too soon, the knowledge gained from enduring the pandemic for two years will be wasted. (WHO, 2022). The Center for Disease Control and Prevention states that viruses evolve constantly. These variations develop over time and can result in COVID-19 variations or novel viral strains. By preventing the virus from spreading to others and yourself, you can prevent the emergence of new variants. On a sad note, the pandemic is not yet over. The World Health Organization's top official (WHO), Tedros Adhanom Ghebreyesus, sent out a warning in his presentation during the 76th World Health Assembly, that the next pandemic must be prepared for by the entire world, which may possibly be "more deadlier" than the COVID-19 pandemic. He further said that the COVID-19 is still a danger to global health despite the fact that it's no longer a health emergency for the public. There is still a risk that a new variant will appear and trigger new outbreaks of illness and fatalities, and the risk from a different pathogen emerging with even more lethal potential remains.

Therefore, the education sector must brace itself to face possibilities. The administration and teachers need to prepare for future uncertainties. Delivering instruction only will be the only option to continue and achieve intended learning outcomes. Teachers must equip themselves with the needs for an online mode of education. In the study of Addimando (2022) on distance learning, it is suggested that in the coming years, we might commit more effort to implementing distance learning technologies as an essential and constant part of the curriculum in every school, up to and including universities. Teachers in the educational field must have the 4Cs (creatively, critically, communicative, and collaboratively) skills for 21st-Century Learning and have a significant impact on the nation's future, empowering learners to meet and conquer the challenges of modern life (Purba, et al, 2022). Additionally, higher education institutions and the Department of Education are necessary to constantly acknowledge the norm of regularly training teachers as regards designing and implementing effective, efficient and transformative teaching-learning processes for distance learning (Collantes, et al, 2022).

It was then the intent of this research to examine and investigate the various important elements the higher education science teachers employed during teaching in times of Covid 19. The review determined the necessary preparations of the teachers when teaching online and at a distance for future outbreak. With the available literature utilizing different strategies in teaching science in higher education, the study explored its implementation. Themes were created to emphasize the common strategies used during pandemic.

2. Methodology

The study used the meta-synthesis design to capture themes from the literatures identified. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram and procedures were employed to investigate the literature. Thematic analysis according to Braun and Clarke was utilized in analyzing the review and identifying themes. The analysis consists of six steps: familiarizing oneself with the data, creating codes, developing themes, reviewing themes, developing themes, defining and labeling themes, and producing the report.

Literature search was done considering the following inclusion criteria; qualitative studies on teaching strategies used by teachers during pandemic in higher education, science teaching, english language, published from 2020-2023 and not systematic review studies. The screening then proceeds with (1) Identifying the articles for review, analysis to eliminate duplicate studies; (2) screening the articles for review, using abstract analysis, studies that don't fit the topic of interest are removed, do not use English language, studies done before pandemic, (3) Deciding on the studies' eligibility, reading the full text of the articles and check if the articles would help to answer the research question; (4) Completing the systematic review's study inclusion list, noting the number of studies to be considered in the flow diagram.

3. Results and Discussion

Figure 1 is the PRISMA flowchart that shows the journal's search, identified and screened. The database search generated 376 articles. Of these, 10 articles duplicated and were eliminated using the Ryann software which resulted in 366 articles left. After the titles and abstract analysis, 268 articles were eliminated. The journals were downloaded and reviewed the full-text of each paper and eliminated 180 journals. There were 88 journals identified. Papers that are not qualitative were 18; not relevant on the nature of the study focus is 29; studies that have a systematic review nature is 8; studies not done during Covid 19 is 2; and some research results that were included in the count came from books, 2.

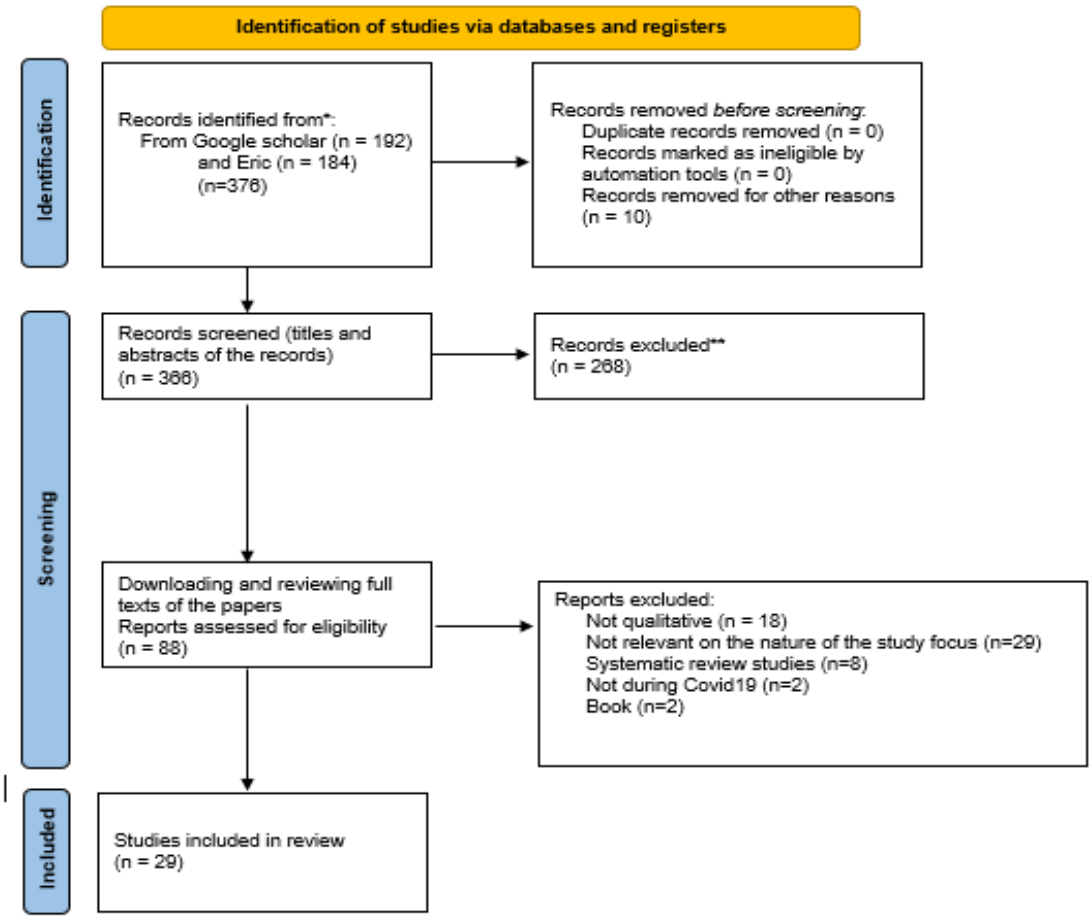

Figure 1. Literature selection and screening using the PRISMA flowchart.

The screening leaves 29 studies for review. The studies identified were conducted from different parts of the globe. Articles identified from the search were from 2020-2023. The studies focused on the teaching of science and higher education's associated disciplines during the COVID 19 pandemic. Thematic analysis showed four (4) themes the science teachers delivered and performed during pandemic; *1) flexible teaching strategies, 2) interactive and participatory technology-aided techniques, 3) teaching skills, and 4) technological applications and tools.*

Theme 1: Flexible Teaching

Science teachers during the pandemic become flexible. They delivered and helped students learn and succeed in an online mode, either synchronous and asynchronous teaching as the most used during Covid 19 pandemic. The following sub themes correspond to flexible teaching online in higher education; a) *self-paced classroom; b) student-centered instruction c) teacher-facilitated environment, and d) collaborative learning space*.

Self-paced classroom

The studies reviewed showed that delivering online in a self-paced classroom was commonly used by the teachers during the pandemic. Jonathan G. Tullis (2011) states that it is important to encourage independent learning among learners. In this setting, learners work through the study material at their own speed and on their own schedule. Self-paced learning, as compared to conventional classroom-based or cohort-based learning, is managed by the learner, not the instructor. Memory performance has improved in self-paced classrooms, but only when provided with suitable techniques are employed. It is a way for a teacher to give the students a chance for one to study at one's own speed and time. In the area of mathematics, The self-paced blended course changed students' perspectives on mathematics and increased their appreciation of it. However, achievement progress during the self-paced blended course and the traditional course preceding it showed no discernible differences (Balentyne, 2016).

Student-centered instruction

Another flexible teaching identified is student-centered instruction. It is a dynamic and experiential approach to education in which learners are active participants. It allows students to discover the benefits of student-centered instruction to both mastery of content and personal growth. Granger (2012) showed students who were enrolled in classes that used a student-centered approach and engaged in scientific procedures had better learning outcomes. However, the result negates the findings of Andersen et al. (2015), those students with low parental education in particular suffer from the negative effects of a student-centered teaching style on academic attainment. In student-centered instruction, the students were given a responsibility of their own learning. It enhanced motivation and involvement, enhanced capacity for critical thought and problem-solving, increased autonomy, and individualized instruction. However, it is identified that the assistance of parents and educators substitute capabilities of students to manage utilizing self-regulatory weights with relation to remote learning. Schools should increase their efforts in the future to promote self-directed learning skills. Self-directed must be acknowledged as a crucial educational competency for academic success and lifelong learning (Berger, 2021). Thus, higher education institutions may consider equipping teachers more in teaching online that promotes self-centered learning.

Teacher-facilitated environment

The foundation of a teacher-facilitated environment is on the notion that giving learners the freedom to make their own judgments will improve their performance in a learning setting, individuals who are respected, and being trusted with personal responsibility. Moon (2018) said in his study that those who were directed reported experiencing less cognitive stress compared to the participants who were not directed. Teacher facilitation with computer-based instruction may be the key to refining venue of control and averages of disruptive students (Powell, 2003). When learning is facilitated by a teacher, there are various benefits for both the teacher and the student. In the context of learners with special needs, computer-based activities with teacher facilitation displayed more complex varying play behaviors and more favorable, cooperative social interactions (Howard et al., 1996). Thus, higher education institutions may promote facilitated class delivery which results in more active online learning whereby the students exhibit and that the instructor has improved in terms of the learning goals.

Collaborative learning space

Collaborative learning space is another avenue for flexible instruction from the papers reviewed. Science instructors from HEI collaborated on initiatives that engaged students working together to develop their minds, or both teachers and students. Students are engaging in pairs or more, together seeking comprehension, solutions or explanations, or producing an output. Collaborative learning space allows students to conduct a wide range of tasks, but focus mainly on how students investigate or apply the course content, not just through the teacher's explanation or presentation of it (Smith, 1992). Small group instruction is a part of collaborative learning, including but not restricted to peer instruction, study groups, learning through projects, learning through problems, and cooperative learning (Koschmann, 1996; Smith & MacGregor, 1992; Udvari-Solner, 2012a). The advantages of collaborative learning are substantial; social, psychological, academic, and assessment benefits (Laal, et al, 2012). It also presented peer-to-peer interaction, Grant (1985, as cited by Maccoby, 1998, Martin et al, 2014). By interacting with each other, learners construct learning experiences that are more tailored to them. Students frequently feel better at ease when they ask questions and can learn more deeply when they clarify concepts. Peer-to-peer education is incredibly adaptable, both synchronous and asynchronous processes can occur.

Collaborative learning space is considered to be a famous strategy when teaching online in higher education. It is stated that the capacity of the small collaborative group to help learners in developing a virtual social presence and allows them to pursue a social construction of knowledge (Stacey, 1999). Thus, more training is encouraged in HEIs that promotes collaborative learning in an online classroom.

Theme 2: Interactive and participatory technology-aided techniques

Different teaching techniques were utilized by the science teachers in higher education. These were found out to be interactive and participatory and with the integration of technology-aided techniques. A teaching technique is a way to conduct a plan to promote the learners' learning. In the interest of accomplishing certain educational goals, it examines teaching in terms of goal-directed connected teaching behavior. It promotes an analytical method of teaching. The teaching method used in a certain teaching-learning setting depends on a number of factors including the goals, the teaching strategies, the students' capacity, the professors' personalities and backgrounds. Interactive and participatory technology-aided techniques that promote learning has the following subthemes; *a) online interactive activities, b) technology-aided instruction, c) compulsory participation, and d) promotes elaboration*

Online interactive activities

This is the first subtheme that sprouts in the review in online teaching techniques. These are classes or educational sessions allowing different levels of student participation online. Online technologies like chat rooms, message boards, and email are used in e-learning activities to facilitate meaningful interactions. Almost any course can integrate these activities at various points (online or in a blended format) to introduce students, spark conversation, encourage connection, debunk stereotypes, and meet a series of instructional objectives (Watkins, 2005). Students gain information by taking part in the search for knowledge by gathering and processing it, by solving problems and articulating what they have discovered. Similar to the activities and exercises used in traditional classroom instruction (Silberman, 2005; Sugar, 1998; Thiagarajan, 2003), instructors can use e-learning activities to achieve a wide range of goals, such as introducing students to one another, exchanging experiences, encouraging team learning, boosting participation, or encouraging students to establish fruitful online relationships throughout the course (Watkins, 2005). With increased attention, curiosity, and interest in the online activity as well as decreased awareness of the immediate environment, students' active learning can be facilitated through interactive online learning resources. The interactive exercise also considerably raised students' test results. Also, this research discovered that the individualized difficulty options offered in the interactive online exercise greatly raised students' perceptions of hedonic value (i.e., enjoyment) and the degree of satisfaction of the activity. Interactive visual learning tools are essential for enhancing students' participation and achievement in online activities (Young, 2020).

Technology-aided instruction

Technology-aided instruction is the next subtheme that came out in the review on techniques in teaching online. Teachers integrate technology in their instruction. When they teach the abstract processes, some microscopic lessons in biology, chemical reactions in chemistry, planets, and geology; technological tools aid instruction during online teaching. the application of technology in education improves students' learning as well. Several forms of technology, such as a virtual classroom, are employed in the classroom to develop students who are actively involved in the learning objective. Teaching and learning are more excellent when technology-assisted delivery methods similar to the flipped classroom strategy and the utilization of reflective e-portfolios are used (Carter, et al., 2018). However, data indicated that face-to-face instruction using technology improved student performance too. The use of technology improved the course by offering a unique, all-encompassing strategy for raising student output (Yedjou, 2022). Teachers and students gain from this greatly from ICT integration. According to Simin (2015), one of the most important factors in the success of technology-based instruction and learning is the equipping of teachers with ICT tools and resources. Also, it was shown that teacher professional development training courses were crucial for improving the standard of students' education. Therefore, HEIs may prioritize acquiring and procuring software and hardware tools which will aid technology in teaching science and other courses.

Compulsory participation

Another important category needed in online teaching in higher education is student involvement. During their teaching online, teachers conducted compulsory participation. When a student is chosen to respond by the teacher, it is regarded as forced or compelled participation. "Cold calling" is another term for this by Dallimore, Hertenstein, and Platt (Bean, J. C. and Peterson, D. 1998). It is usually used to characterize students' tendency to participate in regular class activities, such as punctuality, timely submission of homework, and following teachers' directions in class, when referring to an element of engagement. Participation in class can vary greatly, including simple questions and explanations from the students (Cornelius, R., & Gray, J. (1988 as stated by Aziz, 2014). Thus, HEI teachers may consider and continue to deliver with students' compulsory participation. It is supported by the study of Ayu (2019) in an English class that promotes interactive activities like requiring student participation in group projects and presentations appears to be an alternative strategy for helping students learn English in a meaningful way and make them excellent communicators in English during teaching and learning process (Ayu, 2019).

Promotes elaboration

Lastly, the result shows that promoting elaboration is one most used technique in teaching science in higher education. Students were given a chance to elaborate and reflect on their learning. In order for students to understand new ideas and teachings, the approach of elaboration is used to assist them discover connections between their personal experiences and what they have already learned. Hamilton (2014) said that specific elaborations outperformed diversified elaborations in terms of concept definition recall, new example classification, and problem-solving performance. When elaborating, critical thinking is important. Elaboration techniques are superior to web teaching-learning strategies for critical thinking and student learning outcomes (Priawasana, 2020). Teachers in HEIs may consider specifically the activity of elaboration especially when teaching online since it will promote critical thinking.

Theme 3: Teaching Skills

Teaching skills are the hard and soft skills that help a teacher keep students engaged. This is the third theme that was found out in the review. Science teachers must continue improving their basic teaching skills. Online environment may be a new avenue of learning but all basic teaching skills will be applied in this new virtual classroom. The multidisciplinary nature of the learning process is influenced by pedagogical, technological, and social factors (da Rocha, 2020). According to Albrahim (2020), the six categories into which skills and competencies are separated are skills related to education, subject matter, design, technology, management, institutional, and social and communication skills. It then supports the results of this review that the following sub themes under teaching skills are; *a) innovative skills, b) social skills, c) communication skills, d) cross-cultural teaching skills, e) integrative skills, f) adaptability skills, g) classroom management skills, h) assessment skills, i) technological skills.*

Innovative skills

Science teachers in higher education innovate. They create, improvised, modify and improve their instructional materials such that it will fit into the learning process. innovative teaching techniques where the teacher creates, but unfortunately, it may not imply the same thing to the learners. Skills to have innovation in teaching is not just "doing" something new; it is "thinking" of new approaches to enhance a service, a procedure, or a concept (Pollock, 2021). The knowledge and skills required to create and adapt to change are known as innovation skills. They enable the application of previously acquired knowledge to the discovery of novel, all-inclusive ideas. Professors actively engage students with cutting-edge methods of instruction and learning that take into account a diversity of learning styles (Rao et al, 2019). Science teachers in higher education are equipped with innovations, therefore, they may continue to improve and apply innovations in their teaching. HEIs may help the teachers through conducting training and seminars on innovations.

Social skills

Teachers in higher education acquired social skills as the data shows. They were able to develop the skill in online classes. It is a need when teaching and dealing with the learners. At the same time, teaching develops both the educational process and the social skills of the students. It measures how well students can build and sustain friendly relationships, get the acceptance of their peers, create and keep friendships, and stop unfavorable or destructive interpersonal connections (Bremer et al., 2004). Gresham et al., (2001) define five dimensions of social skills: (a) peer relational skills, (b) self-management skills, (c) academic skills, (d) compliance skills, and (e) assertion skills (pp. 333-334). Many methods may be employed to teach social skills, including such direct instruction, peer learning, problem behavior prevention, and children's literature (Lynch & Simpson, 2010). Improving social skills in the classroom for the teachers is relevant. This is one avenue that the universities will prioritize to equip the teachers in their teaching.

Communication skills

Science teachers find communication skills important when teaching online. It primarily allows one to both comprehend and be understood by others. Among these are public speaking, giving and receiving constructive criticism, actively listening during talks, and effectively communicating ideas to others. Classroom is a complex communication space. The goal of communication procedures is to control teacher and student behavior. There are verbal, nonverbal, and paraverbal components to these processes (Muste, 2016). The academic success of the students is significantly influenced by the teacher's communication skills (Khan et al, 2017). When determining how effective a teacher is, communication skills are just as important as subject-matter expertise. If instruction is to be effective, neither should be subordinate to the other. Currently, content knowledge is prioritized in teacher education but communication skills are given less weight (Okoli, 2017). Software tools to improve communication may be procured by universities. Teachers need to give priorities to enhance communication in order to deliver online classes effectively.

Cross-cultural teaching

Teaching and dealing with learners from different cultures is also a skill. The review shows that science higher education teachers recognized cross-cultural education in their delivery in the classroom. A structured educational experience, such as a course, lecture, workshop, or other organized training, that focuses on the characteristics and differences among other cultures or groups is known as cross-cultural education. While maintaining the effectiveness of personal, culturally derived modalities of knowledge of students, by serving as a tour operator, travel agent, or cultural intermediary, teachers are required by the teaching to recognize and encourage the cultural border crossings that their children will encounter (John Wiley & Sons, 1997). According to cultural border crossing, significant cultural differences between students' home cultures and the culture of the science classroom may be experienced by them. They could need assistance to cross these cultural barriers (Green & Delgado, 2021).

Integrated skills

The ability to integrate a lesson to different disciplines was considered by the science higher education teachers in their teaching online. They were able to connect lessons to different disciplines. Integrating subjects or abilities that often address a variety of subject areas involves drawing important links between them. In the study of Savvidou (2003) in the English area, learners are given analytical techniques through an integrated approach to the use of literature and interpret language in context to understand not only how but also why language is used in certain ways. Higher education teachers are then encouraged to improve their integrated skills when teaching. Universities may conduct training to equip teachers with integrated skills.

Adaptability skills

Another skill developed by the higher education teachers during pandemic is adaptability skills. The fact that teaching work constantly involves novelty, change, and uncertainty is one of its distinguishing features. Being

able to adapt to this shift successfully made the teacher become adaptable in the classroom. According to Martin et al. (2012), adaptation is the ability to "constructively manage psycho-behavioral functions in response to novel, evolving, and/or unpredictable circumstances, contexts, and scenarios" is referred to as adaptability." Academic achievement, school satisfaction, levels of happiness, a sense of purpose and significance, and adaptability were all positively correlated. Given that responding to and managing continuous changes are critical features of teaching, adaptability is also very important for teachers (Collie & Martin, 2015).

Classroom management skills

Students' behavioral conduct can be strongly predicted by teachers' classroom management abilities (Kayikçi, 2009). Agbaria (2021) shared in the study that emotional intelligence and self-efficacy are strongly correlated with classroom management abilities. The atmosphere of a classroom is essential. Learners enjoy coming to school for a variety of reasons, such as the chance to create a positive learning environment. When teachers are very well managed, it has a favorable effect on the academic performance of the learners. Science professors' many advances in classroom management techniques produced successful online courses. (Hermoso et al., 2022). As a result, universities may offer instruction in proactive classroom management for students taking courses online.

Assessment skills

Teachers need to improve assessment skills. Online classes during pandemic identified assessment skills as one playing its significant role. Among a teacher's fundamental job function has been recognized as assessing, grading, and evaluating students (Rosenfeld, et al, 1986) and it has been discovered that teachers can devote up to one-third of their class time on activities linked to assessment (Stiggins, 1987). Indeed, Smith et al., (1980) and Gulliksen (1986) made the case that evaluation skills are a must for all teachers. Regardless of their level of instruction, teachers who have undergone measurement training report offering excellent self-perceived assessment skills when using performance measures, conducting standardized tests, revising tests, improving instruction, and presenting assessment results (Zhicheng Zhang et al., 2010). Hermoso et al., (2022) also recommended positive feedback in teaching.

Technological skills

When teachers shift to online teaching, technological skills were developed by the teachers to effectively deliver the lesson online. The data shows that the teachers are skillful and utilize technology. For the learners, shifting to online classes made them improve and develop their handling and usage of technology. Throughout their academic careers, students have the chance to learn and grow in a variety of skills from fundamentals through secondary and eventually higher education., including technology. It is vital for students' personal, social, and professional futures in higher education as well as for their standard of living because The change in how academic work is organized, interactions between students, teachers, and institutions, and novel approaches to teaching and learning in an online learning environment all benefit from the integration of digital technologies (Rodrigues, et al., 2021).

Theme 4: Technological applications and tools

Science teachers in higher education equip themselves with tools and applications in online delivery. These tools include; a) online conference tools, b) online assessment tools, c) online communications tools, d) online documents, e) online laboratory tools, and f) online interactive videos and applications.

Online conference tools

Science teachers in higher education often use online conference tools to deliver the lesson to the learners. These are in the form of google meets, zoom, Microsoft and other tools available. Users in various locations can hold face-to-face meetings in real time using this technology, often for little or no expense. This has offered teachers new methods for interacting with students and presenting materials, and as a result, they are encouraging the creation of practices that are compatible with modern technologies. Through the Internet, video conferencing uses simultaneous two-way voice and two-way compressed video (Gladović, 2019).

Online assessment tools

Teachers need to assess learning. Teachers during the pandemic used online assessment tools. Based on the review, different online tools were utilized by the teachers. In science, labelling tools, virtual laboratories were used for assessment. It might be difficult to control the resources that students use to aid with their learning and/or assessment tasks. Online assessment technologies, particularly quiz applications, provide teachers and students with quick feedback and correction (Vurdien, 2022). Students' attitudes regarding geography classes dramatically improved because of online assessment tools (Sözen, 2019). Despite their limited use of the cognitive learning elements, students nevertheless performed well on tests utilizing the online tool, raising concerns about how well the platform supports long-term learning (Shaw, 2019). Students who performed excellently on the online tests also did better on the conventional tests. Although pre-test and post-test measures are most frequently employed in terms of learning, the gap-closing measure of performance was not a strong predictor of final grade, indicating that other learning measures may need to be employed to predict final grades using online assessment tools (Amoroso, 2005). The most effective technique to teach online might be to use ongoing feedback loop. (Hill, 2021). Universities may purchase paid online assessment tools to aid online teachers' assessment and evaluation of learners' learning.

Online communications tools

The review shows online communication tools as the primary tool in online delivery. The use of google chats, email, facebook messenger and other available communication tools were used. With the growing use of adjunct faculty and the increase of technology available to faculty and students, implementing online communication tools could help to bridge the challenge of offering more faculty/student engagement outside of the classroom setting. The formation and development of written communication abilities are positively impacted by the incorporation of online communication tools (Martyushev, et a., 2021). The development of collaborative skills is impacted by electronic communication tools. However, a study found that when engaging in online group activities, synchronous communication tools are more effective than asynchronous ones for fostering collaborative learning skills. The study suggests that synchronous communication tools should be used in online group activities to foster collaboration (Khalil, 2017). Further, the higher education institution may promote synchronous classes when using communication tools online.

Online documents

Teachers every now and then create document files in teaching. The review shows using documents online is also an important tool for convenience and access online. When opposed to face-to-face engagement, online document collaboration solutions like the online office suites Google Docs, Drive, Sheets, and Slides provide designers alternative methods of communication and teamwork. On the other hand, there are various effects of collaborating on documents online and in person during the design process. These effects have been recognized, along with the attributes that provide various aspects of design problem-solving activity (Jung, et al., 2017). A website resource known as an online documentation portal includes various online resources that a business offers. Online document collaboration solutions are becoming more commonly accessible and frequently free of charge as a result of the development of Web 2.0 technology. Although the technology is said to be interactive and collaborative, this does not necessarily imply that students will connect with and work together in this manner (Vallance, 2009). It is fortunate that some universities procured large storage for online document tools. It is highly recommended for easy and convenient access of files.

Online science laboratory tools

Science teachers during the pandemic were able to explore science laboratory tools. Interactive, digital simulations of tasks that are usually carried out in physical laboratories are referred to as virtual labs. The equipment, tools, tests, and processes used in chemistry, biochemistry, physics, biology, and other fields are all emulated in virtual labs. Non-traditional labs are increasingly utilized in higher education. These non-traditional approaches of performing science experiments are just as effective at delivering the desired learning outcomes as conventional lab methods (Faulconer, et al., 2018). Their previous experiences in the traditional setting were comparable to or superior to their online laboratory experiences. Additionally, survey results demonstrate that students think their laboratory experiences strengthened and enhanced their comprehension of the ideas offered in lectures and the textbook, perhaps enabling them to do better on course exams (Rowe, et al., 2018). When it came to adjusting

their curriculum for the internet environment, science teachers had great success. Finally, according to the data analysis, educators should think about strategies to close the knowledge gaps brought about by the change to online learning and to capitalize on students' enthusiasm for science by encouraging them to pursue STEM careers. (Hill, 2021).

Online interactive videos and applications.

Interactive videos and applications play a significant role during the pandemic's educational efforts. The user can interact with the content they watch using interactive video. These have clickable elements that either direct users to another webpage or to another part of the movie. In general, interactive videos would engage students and increase their awareness of the video's subject. (Kolås, 2015). They include advantages including improved classroom dynamics, independent learning, efficiency, and efficacy in learning. Students handled their own progress with success and displayed good self-control, discipline, and independence in learning. The suggested learning environment may prove to be an effective way to encourage interactive learning at one's own pace in a classroom (Palaigeorgiou, 2019). Additionally, interactive recordings and comments of teachers conducting experiments can be employed to create inquiry-based science learning. (Hill, 2021).

4. Conclusion and Recommendation

During the epidemic, professors in science and across disciplines in higher education developed new methods for delivering their courses online. Teachers performed and acquired flexible teaching strategies, interactive and participatory technology-aided techniques, teaching skills, and technological applications and tools. They adapt to any online mode, including synchronous and asynchronous, and deliver content as well as support learning and success for students. Flexible teaching online in higher education delivers through the following strategies; a) self-paced classroom; b) student-centered instruction c) teacher-facilitated environment, and d) collaborative learning space. Interactive and participatory technology-aided techniques integrate technology and encourage student involvement in the class. The integration and participation may promote online interactive activities, technology-aided instruction, compulsory participation, and promotes elaboration. Teaching skills in teaching science in higher education were improved by the teachers. These are the hard, soft and innovative skills. Categorically, these are a) innovative skills, b) social skills, c) communication skills, d) cross-cultural teaching skills, e) integrative skills, f) adaptability skills, g) classroom management skills, h) assessment skills, i) technological skills. Technological applications and tools were considered commonly used in teaching during pandemic. These tools include; a) online conference tools, b) online assessment tools, c) online communications tools, d) online documents, e) online laboratory tools, and f) online interactive videos and applications.

It is highly recommended that higher education institutions will enhance and empower teachers in science and in different disciplines for online teaching. This will make them prepared with uncertainties of time. In order to improve their delivery and prepare for potential future health outbreaks, HEIs may hold training sessions, seminars, and workshops on acceptable teaching methodologies, techniques, and other teaching abilities.

5. Implications

Teachers in HEIs performed and acquired flexible teaching strategies, interactive and participatory technology-aided techniques, teaching skills, and technological applications and tools in their online classes in different disciplines. These showed that teachers in HEIs were equipped with proper training and acquired basic skills in teachings such as the strategies and techniques. Teachers' exposures to technology prior pandemic helps a lot in their online delivery. The integration and utilization of online tools and applications significantly aids teaching in an online environment during pandemic.

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